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EDITORIAL

NATURE MUST NOT BE ABUSED

THE advance of knowledge has been constant since the dark ages. For long this advance was slow. Those who would pursue a line of research often worked in the dark for want of a true understanding of the basic or fundamental facts on which all sound scientific research must be founded. In spite of this disadvantage there is no doubt that great discoveries and advances were recorded albeit that according to modern scientific practice, those experiments and their results would be classified as empirical in conception. Whilst this method of approach was going on, and often it had to go on under the compelling urge of necessity, scientists could turn aside every now and then to try and elucidate the why and wherefore of some basic fundamental fact. Gradually the amount of knowledge on these matters has increased to such volume and force that the modern scientist is able to approach his problems, by stepping, as it were, on to solid stone steps instead of into a void.

As a direct result of these efforts it is not surprising that man inflated by his own self-esteem, apparent omnipotence and knowledge has turned his attention to an attempt to alter the laws of nature rather than to stimulate, control or use them wisely. Now, this line of approach is fraught with danger, and especially is it so regarding the animal and vegetable life of the world. All natural processes, be they in plant or animal, observe one law and that is ecological balance. It is through this finely wrought structure that life has been able to persist. There are many examples manifest which demonstrate that when this balance has been upset between two species of animal then the result is adverse in both cases. Natural laws hold good not only in the case of species *v.* species but in regard to all natural phenomena, including the physiological response of the body to environment, food, and even parasitic invasion.

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At the present time the population of the world is increasing rapidly as a direct result of advances in our knowledge of medical and sanitary science. On the other hand the sources of food are not increasing in like measure because of man's wrongful interpretation of the lessons of science and his disregard of natural laws.

Of all the foods in short supply those rich in animal protein rank high in the list, and shortage of this type of food is fraught with danger to health. The obvious way to increase this protein food is to increase the output of meat of all kinds. Now such an increase means a multiplication of the animal population and indirectly there will be more mouths to compete for the products of the field. There are two ways in which this demand can be satisfied, i.e., increase the acreage or increase the yield. At the present time the latter method offers the greater chance of reward, and no doubt scientists will be busy on this job. Intensification of yield may bring incalculable harm if our farmers and research workers do not pay due attention to natural laws. There is already evidence that new methods, which go contrary to these laws, are often successful in increasing yields, but they bring new troubles in their wake. One can quote digestive ailments associated with ley farming, reproductive abnormalities associated with subterranean clover in Australia, and the field mouse and the honey harvest, to mention just a few which come immediately to mind.

It may be also that modern chemical anti-parasitic treatments, which appear to bring immediate benefits, may in their turn produce ill-health in animals or they may so upset the natural ecological balance in nature that in the long run they may bring harm instead of good.

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GENERAL ARTICLES

PIG FEEDING TRIALS WITH 2 : 3 : 5 : 6— TETRACHLORONITROBENZENE (TCNB)

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THE chemical compound 2 : 3 : 5 : 6-tetrachloronitrobenzene (TCNB), first described in 1868, has been utilised as the fungicidal ingredient of the proprietary product " Fusarex,"* recently introduced for the control of dry-rot disease of clamped potatoes caused by the fungus, *Fusarium cæruleum*. During the course of studies (Brown, 1947) on the fungicidal effect of " Fusarex " it was noted that this substance also possessed the property of repressing, or of retarding, sprout development of potatoes during storage without affecting the field growth of the potatoes when subsequently used as seed.

As sold for routine use, " Fusarex " is a greyish-white, odourless powder, which is stated to contain 3 per cent by weight of TCNB in an inert powder base. The makers recommend that it be dusted on the potatoes before clamping at a dosage level of 10 lb. of " Fusarex " per one ton of potatoes.

TCNB is a relatively stable compound, only slightly soluble in water. No decomposition products from it have been detected either in the soil or on potatoes at three months after treatment with " Fusarex."† It is said that TCNB volatilises only slowly in a closed atmosphere but becomes appreciably volatile if exposed in a moist, warm current of air. (Report No. III, Sterling-Winthrop Res. Inst.) The fungicidal and sprout-repressing actions of TCNB appear to be dependent on its relatively slow volatilisation rate under the conditions of clamp storage. We are informed that the effective ingredient is dissipated from " Fusarex "-treated potatoes probably only after a period of from six to eight months if the potatoes are stored in a closed clamp, whereas when treated potatoes are left unclamped in the open air, or in trays, little control of dry rot is secured because of the relatively general volatilisation of the TCNB.

Whilst " Fusarex " was originally designed for the treatment of seed potatoes, the discovery of its high fungicidal efficiency, and also that of its sprout-repressing action, pointed the way to its possible use on potatoes assigned for the feeding of animals or for human consumption. The purpose, therefore, in undertaking the investigation herein reported was to determine whether the eating by pigs of potatoes recently treated with " Fusarex " could result in any toxic manifestations in this species.

* " Fusarex " is prepared and marketed in Great Britain by Bayer Products, Ltd., Africa House, Kingsway, London.

† Personal communication from Dr. M. L. Bird, Bayer Products, Ltd., Crawley Research Station, Crawley.

Methods

Feeding.—Eight pigs of the Large White breed were fed over a period of 26 weeks, viz., from the beginning of the eighteenth week of their age to the end of the forty-third, on a diet consisting of a standard meal mixture (National Pig Food No. 2) and boiled potatoes. The pigs were fed twice per day, the daily ration being in accordance with the scheme shown in Table 1.

TABLE 1

Feeding Schedule during Experimental Period

Age of pig	*Daily ration*
18-20 weeks ...	2½ lb. meal mixture and 4 lb. boiled potatoes.
20-22 „ ...	2½ „ „ „ „ 6 „ „ „
22-24 „ ...	3½ „ „ „ „ 10 „ „ „
24-26 „ ...	4 „ „ „ „ 10 „ „ „
26-36 „ ...	4 „ „ „ „ 14 „ „ „
36-43 „ ...	3 „ „ „ „ 14 „ „ „

The pigs were penned in four groups, each consisting of two animals. To the pigs of three of these groups " Fusarex " was administered via the food; the fourth group was fed the same ration as the other three groups but without " Fusarex." The following summary gives the essential details regarding the dosage level and the stage of food preparation at which TCNB was added to the potatoes fed to the different groups of pigs :—

Group I (*Pigs No.* 6 *and* 3): A 3 per cent TCNB inert dust-mixture (commercial " Fusarex ") was applied to the potatoes at the rate of 8 ozs. of the mixture per 112 lbs. of potatoes, or 60 mg. of TCNB per lb. of potatoes. This is the amount of " Fusarex " advocated by the manufacturers for actual field use. After this treatment the potatoes were boiled, admixed with the meal and fed to the pigs.

Group II (*Pigs No.* 7 *and* 2): Potatoes were dusted with a 20 per cent. TCNB inert dust-mixture at a rate of 8 ozs. of the 20 per cent powder per 112 lbs. of potatoes, or 400 mg. of TCNB per lb. of potatoes. The unpeeled potatoes were boiled after the TCNB dusting, mixed with the appropriate amount of meal and fed to the pigs. From the tenth week until the end of the experiment an additional 42 g. of the 20 per cent dust-mixture per pig per day were added to the food, just prior to feeding (see below).

Group III (*Pigs No.* 1 *and* 4): The pigs in this group received untreated boiled potatoes, and thus served as negative controls.

Group IV (*Pigs* 5 *and* 8): For this pen a 20 per cent TCNB inert dust-mixture was added directly to the potato-meal mixture *immediately before feeding* in an amount approximately 10 times that which is recommended for the field treatment of potatoes, i.e., 3 g. of the 20 per cent powder per lb. of potatoes, or the equivalent of 20 g. of the 3 per cent " Fusarex," or 600 mg. of TCNB per lb. of potatoes.

The water in which the potatoes for groups I and II had been boiled was conserved separately and later mixed with the appropriate potato-meal ration, the aim of this procedure being to ensure that any TCNB dressing that might be " washed " from the potatoes during the boiling should not be omitted from the pigs' intake.

The total amount of 20 per cent TCNB inert dust-mixture added to the diet of the pigs of group IV during the 26-week experimental period was 6,480 g., or 1,296 g. of TCNB. This gives an average intake of 7.1 g. of TCNB per pig per day.

From the above summary it will be seen that at any given time the pigs in group IV received ten times as much TCNB in the food as did those in group I, and that, therefore, the total quantity of TCNB ingested by the animals of group IV was ten times the amount ingested by those of group I. There was also the further difference between these two groups that whereas the TCNB ingested by the pigs in group I had been subjected to boiling, that ingested by the animals in group IV had not been boiled.

It became evident after the first nine weeks of experimental feeding that the average weekly live-weight gain of the two pigs receiving the highest TCNB intake, i.e., group IV, was not as great as the average gains of the animals in the other groups. With a view to determining whether the slower live-weight gain of the group IV pigs could be attributed to their higher TCNB intake, it was decided at this stage, i.e., at the beginning of the tenth week, to raise the TCNB intake of group II by adding a further 42 g. of the 20 per cent dust-mixture to the daily ration of each pig just before feeding (see also under group II above). This addition is equivalent to 8.4 g. TCNB per pig per day.

Post-mortem Investigation: The pigs were slaughtered after having been 26 weeks on diets containing TCNB; they were then 43 weeks old.

The carcases of all the experimental pigs were submitted immediately after killing to inspection for the presence of macroscopic abnormalities. From the negative control pigs (group III) and from those having the highest total TCNB intake (group IV), the liver and kidneys were removed for chemical and histological examinations. Portions of the body fat of these same pigs were also taken for determination of unsaponifiable matter content. At the time of slaughter, blood samples were obtained from the four above-mentioned pigs; these were submitted to hæmatological examination.

Examination for Carcase Taint: Portions of the carcasses of each of the pigs in groups III and IV were submitted to independent observers for report as to possible presence of abnormal flavour in the cooked meat.

Chemical Methods: Portions, each weighing 50 g., of liver and kidneys, having been freed of adherent fat and surrounding connective tissue, were ground up with sand to which 100 ml. absolute alcohol had been added. The tissue-sand-alcohol mixture was dried in a hot-air oven prior to being extracted successively for eight hours each with absolute alcohol and ethyl ether. Of the

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combined extractives, after evaporation of the solvents, successive small extractions with cold acetone were made in order to separate lipoids present into "glyceride plus unsaponifiable matter" and "phosphatide" fractions.

For determining the content of unsaponifiable matter of the body fat, samples weighing approximately 100 g. were digested with alcoholic potash, according to standard chemical procedure.

Results

Live-weight gain: In Table 2 are given the data relating to gain in the live-weight of the pigs for each of the two stages of the experimental feeding period, namely, from the first to the ninth week inclusive and from the tenth to the twenty-sixth week inclusive. The actual ages of the pigs corresponding to these two feeding stages were 18-26 weeks and 27-43 weeks respectively.

TABLE 2

Live-weight Data

		Actual weight gains (lb.) during experimental period			Average weekly weight gains (lb.) during experimental period			Final live-weight
		Weeks		Total				
Group	Pig No.	(i) 1-9	(ii) 10-26	(i) & (ii)	Weeks 1-9	Weeks 10-26	Weeks 1-26	(lb.)
I	6	84	140	224	9.3	8.2	8.6	308
	3	90	168	258	10.0	9.9	9.9	364
II	7	94	163	257	10.4	9.6	9.8	369
	2	97	172	269	10.8	10.1	10.3	367
III	1	74	149	223	8.2	8.8	8.6	308
	4	90	171	261	10.0	10.1	10.0	339
IV	5	59	152	211	6.6	8.9	8.1	306
	8	69	150	219	7.8	8.9	8.4	325

At the end of the six-month feeding period there were no significant differences in the live-weights of the TCNB-treated pigs and the controls. The final weights of all the pigs, now 43 weeks old, ranged from 306 lb. to 369 lb., whilst the total gain in weight for individual animals during the experimental period ranged from 211 lb. to 269 lb.

The most important finding in the data summarised in Table 2 is that during the first stage of experimental feeding, i.e., from weeks one to nine, each of the two pigs (Nos. 5 and 8) in group IV showed a distinctly lower weekly increment of live-weight gain than did any of the six pigs in the other three groups. In the second stage of feeding, i.e., from weeks ten to twenty-six, there were no significant differences in the average weekly live-weight gain of the pigs in any of the four groups.

Health: At no time during the course of the experiment were symptoms of ill-health observed in any of the pigs.

Post-mortem Examination: At the post-mortem examination carried out immediately after slaughter, no gross abnormalities were detected in any of the eight pigs involved in the experiment.

Histological examination of sections prepared from the liver and kidneys of each of the pigs in groups III (controls) and IV, indicated that no tissue damage had occurred in either of these organs from any of the four animals concerned.

The findings of the hæmatological investigation are given in Table 3. There is no significant difference between the blood pictures of the two groups examined, and the individual values obtained may be taken as falling within the normal range for pigs of this age.

TABLE 3

Hæmatological Examination

	Group III		Group IV	
	Pig 1	Pig 4	Pig 5	Pig 8
Erythrocytes (x 10^6/cu. mm.)	8.6	7.2	8.5	11.8
Leucocytes (x 10^3/cu. mm.)	16.6	9.2	14.9	13.0
Hæmoglobin (g./100 c.c.)	13.80	11.73	14.35	14.49
Colour index	0.6	0.6	0.6	0.5
Methæmoglobin (spectroscopic test) ...	Nil	Nil	Nil	Nil

Examination for Carcass Taint: Nothing unusual either in the appearance or in the flavour of the roasted meat (pork) from any pig in groups III and IV was detected by a number of independent observers to whom samples were submitted. Similarly, sides of the carcasses which were subjected to curing as bacon proved to be normal as regards fat colouration, flavour, and keeping quality of the meat as a whole.

TABLE 4

Chemical Analysis

	Group III		Group IV	
Tissue examined	Pig 1	Pig 4	Pig 5	Pig 8
Body fat—				
Unsaponifiable matter, %	0.02	0.03	0.02	0.11
Liver—				
Glyceride + unsaponifiable, % ...	1.80	1.30	1.89	2.20
Phosphatide, %	5.43	3.62	5.38	3.95
Glyceride/phosphatide ratio	0.33	0.36	0.33	0.56
Kidney—				
Glyceride + unsaponifiable, % ...	1.58	1.46	1.36	2.64
Phosphatide, %	3.45	3.29	3.37	3.09
Glyceride/phosphatide ratio	0.46	0.44	0.40	0.85

Chemical Analysis: Table 4 gives the results of the chemical examination carried out on samples of body fat, liver and kidney from each of the four pigs

in groups III and IV. It will be seen that pig No. 8, one of the two pigs having the greatest total intake of TCNB, shows some deviation from the other member of group IV, i.e., from pig No. 5, and also from both the pigs (Nos. 1 and 4) of the control group, in respect of the values obtained for percentage of unsaponifiable matter of the body fat and for the glyceride-phosphatide ratios of liver and kidney respectively.

Discussion and Conclusion

Comparison of the live-weight increases of the pigs in the four groups (see Table 2) for each of the two stages into which the period of experimental feeding has been classified indicates that in the first stage (weeks 1-9), when the pigs were 18-28 weeks old, a daily intake of 7.1 g. of TCNB per head resulted in a definite retardation of growth rate in the two animals on this dosage (group IV), but produced no other symptoms and apparently no detectable tissue damage of a permanent kind. In the second stage of experimental feeding (weeks 10-16), when the pigs were now 28-43 weeks old, and during which the daily intake of TCNB continued at the level of 7.1 g. per head, any retardation of growth rate of the two pigs in group IV, as judged from the figures shown in Table 2, is much less evident. The final live-weights recorded before slaughter at 43 weeks old for each of the two pigs in this group, and the total live-weight increase for the whole of the experimental period, both appear to be somewhat lower than the corresponding figures for the control group, but the differences are not statistically significant. It may be concluded, therefore, that a continued daily intake of 7.1 g. of TCNB caused growth retardation in pigs up to about 6-7 months of age, but that thereafter there was little or no decrease in the growth increments as compared with those of the controls, although the final live-weights at about 10 months of age were slightly less than those of pigs not subjected to a growth check in the first stage of the fattening period. This conclusion is supported by the growth data for the pigs of group II (Table 2), where the daily intake per head for the second stage of the experimental period amounted to 8.4 g. of TCNB, directly added to the ration before feeding, plus a further undetermined quantity resulting from the application of 20 per cent TCNB dust-mixture to the potatoes before they were cooked.

When the present investigation was initiated there was no reliable information about the possible pharmacological effects arising from the ingestion of high dosages of TCNB by animals. In planning the chemical part of the investigation, therefore, the choice of analytical tests had to be made largely on the basis of existing data regarding the pharmacology of related compounds. Thus, since TCNB contains an aromatic nitro-group, this compound might, therefore, be suspected of being capable of producing a methæmoglobinæmia, as is the case with nitrobenzene. Spectroscopic tests carried out with blood samples from the experimental pigs clearly negatived this supposition. Secondly, being a chlorinated hydrocarbon, TCNB could possibly be expected to produce disturbances in hepatic and in renal function.

Histological examination of liver and kidney, however, revealed no evidence of morbid functional changes in these organs. This latter finding, it was thought, could most usefully be supported by chemical analysis of the lipoid fraction of liver and kidney tissues. Since compounds related to TCNB, such as chloroform, carbon tetrachloride, and many of the chlorinated hydrocarbons, are known to be capable of altering the normal ratio of glyceride to phosphatide in the tissues of animals to which they are administered in high dosages, estimations were made of the glyceride plus unsaponifiable matter and phosphatide contents of the livers and kidneys of these pigs having the highest total ingestion of TCNB (group IV) and of the controls (group III). In the case of one pig (No. 8) in group IV, the glyceride-phosphatide ratios obtained for both liver and kidney were distinctly higher than those for the two control animals and for the other pig (No. 5) of group IV, the last three pigs, in fact, showing no real differences from one another. Because there were only the two animals in group IV, no significant conclusion can be drawn regarding the aberrant chemical findings in respect of pig No. 8. It might be suggested that the amount of TCNB ingested by pigs No. 5 and 8, viz., 7.1 g. per head per day over a period of six months is just about the threshold level for producing toxic changes in the body tissues, but the histological findings give no support to such a hypothesis.

The question as to whether or not TCNB accumulates in any of the body tissues following ingestion is of considerable importance both from the animal health standpoint and from that of the production of pig meat for human consumption. For these reasons, then, the unsaponifiable matter content of the body fat of the pigs in groups III and IV was also determined. The percentage value for unsaponifiable matter in the body fat of pig No. 8 was found to be higher than the values both for its group companion (No. 5) and for the two animals of the control group. The actual value, viz., 0.11 per cent, for pig No. 8 is not, however, unduly high for the unsaponifiable matter content of pig fat, and, therefore, little significance may be attached to the differences between the values for pig No. 8 and those for the other three pigs examined (Nos. 5, 1 and 4). Unfortunately, for technical reasons it was not possible at that time to make direct tests for the presence of TCNB in the unsaponifiable matter, but some progress has since been made in developing methods for the direct determination of TCNB in animal tissues, and it is hoped to utilise these techniques in further work, now in progress, on the extent to which TCNB may be stored in body fat and other tissues after its ingestion.

The urgency of obtaining information regarding the pharmacological effects of TCNB in animals made it necessary for our effort to be concentrated on this particular aspect, and no attempt could be made to follow the metabolic path of TCNB following its absorption into the body.

The post-mortem, chemical and histological studies confirm the findings arrived at on the basis of the growth rate data, namely, that the long-continued ingestion of an amount of TCNB as high as 7.1 g. per pig per day may cause a slight depression as compared with the average growth rate for this species. As

this quantity of TCNB is ten times as high as that which will be used for the routine dressing of potatoes, it is improbable that the consumption of "Fusarex"-treated potatoes by pigs will result in an toxic manifestations attributable to TCNB. In the case of potatoes which have been stored for long periods after they have been dressed with " Fusarex " the probability is still smaller.

Summary

The effects of 2 : 3 : 5 : 6-tetrachloronitrobenzene on the growth rates and certain of the organs of growing pigs have been examined. At the levels of intake which would be likely to occur with pigs where the compond is used in the manner recommended for the dressing of potatoes, no adverse effects were observed.

Acknowledgments

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RIB COUNTS ON PIGS OF BRITISH BREEDS, AND THEIR FAMILIAL INHERITANCE

By Dr. W. P. BLOUNT.

At one or two pig conference recently there has cropped up the question of the number of pairs of ribs in the different breeds of pigs, and their relationship to the production of bacon.

Anthony, in his " Diseases of Pigs," 3rd edition, 1950, states that the Welsh pig tends to exceed the average number (" about 14 pairs ") of ribs, having as many as 17 pairs, thus giving " a good, lengthy side of bacon." He says that the Large White and Large Black breeds also give high rib counts; and that rib counts on pigs of various British pure-breds show a remarkable constancy in placing the three long-nosed breeds mentioned amongst those with 14 pairs of ribs.

At the recently completed First National Pig Litter Test, sponsored by the British Oil and Cake Mills at their demonstration farm, Stoke Mandeville, an opportunity was taken to include rib counts in the data obtained from an examination of the 172 carcases involved. This was arranged by Mr. Collan Brett, of Messrs. T. Wall and Sons, at their London bacon factory, Willesden,

and to him and his colleagues our best thanks are due. The result was as follows:—

TABLE I

Number of pigs examined	Breed	Average number of ribs	Rib counts 14 pairs	15 pairs	16 pairs	17 pairs
97	Large White ...	15.1	19	58	20	0
25	Wessex	15.0	7*	17*	1	0
23	Essex	14.8	6	16	1	0
10	Large Black ...	14.4	6	4	0	0
7	Berkshire	14.7	2	5	0	0
5	Welsh	15.0	0	5	0	0
3	Gloucester Old Spots	14.3	2	1	0	0
2	Tamworth	15.0	0	2	0	0
172		14.8	42	108	22	0

* One pig with 14 ribs on the right side and 15 on the left.

In our experience, therefore, the statement by Sisson, in his "Anatomy of the Domesticated Animals," that the pig has 14 or 15 pairs of ribs, could be extended suitably to include 16 pairs. The percentage distribution of each, in the eight British breeds examined, being: 14 pairs, 24.4 per cent; 15 pairs, 62.8 per cent; and 16 pairs, 12.8 per cent. In no case was 17 pairs present, so that in this instance we were not able to confirm Anthony's work, but further opportunities will be available to us as other Litter Tests are completed, the second of which ended in August. Certain it is that one should not recommend unreservedly the use of Welsh boars in the belief that this breed necessarily possesses 17, or even 16, pairs of ribs.

In the Litter Test mentioned, half-litters of pigs were received at 10 weeks of age, consisting of three hogs and one gilt, and it is of interest to note, therefore, that in only 12 out of the 50 teams entered was the number of ribs the same for all pigs examined. (As each hog reached 200 lb. liveweight it was slaughtered and the carcase judged for quality—the fourth pig, the gilt, was available for return to the farmer for breeding purposes.) As some farmers did not require their gilts returned to them, they, too, were examined, making four pigs per team killed for bacon production. The results of the rib counts in terms of sex distribution was as follows:—

TABLE II

	Rib counts Pairs of ribs 14	15	16
Hogs (147) ...	37 (25 per cent)	93 (63 per cent)	17 (12 per cent)
Gilts (25) ...	5 (20 per cent)	15 (60 per cent)	5 (20 per cent)

Owing, however, to the comparatively small number of gilts involved it is doubtful if there is any significance in the higher percentage of 16 paired rib females. Now, although 12 out of 50 teams of three hogs (each from the same litter) all had the same number of ribs in each pig of each team, in those instances where all four pigs were examined this number was reduced to two (Table III). The heterozygous nature of the condition was, therefore, evident markedly, and pig breeders cannot assume that the use of breeding stock whose progeny reveal 15 or 16 pairs of ribs will necessarily result in this same number being transmitted with any certainty to their offspring.

TABLE III

Distribution of teams, each member with the same number of ribs.

	14	15	16 Pairs of ribs	
Teams of 3 brother hogs	2	7	1	Total 12
Half-litters of 4 pigs (3 hogs and 1 gilt) ...	0	2	0	Total 2

Number of teams examined: 50.

Our examinations covered half-litters only, but I feel certain that had we been able to examine the complete litters we would not have found one with the same number of ribs in each piglet.

ANTIBIOTICS IN SHORT AND STREPTOMYCIN-PENICILLIN MIXED BEFORE INOCULATION

By Professor Z. MORCOS, F.R.C.V.S., M.V.Sc., D.V.H.,

Professor of Bacteriology, Cairo Veterinary College (*September*, 1950)

Literature

THE study of antibiotics was commenced in 1877 by Pasteur and Jubert, who found that common bacteria in urine prevented the growth of anthrax, and even suggested therapeutic use might be made of this fact.

Garre, in 1887, developed technical methods for the study of bacterial antagonism.

Emmerich and Low (1899) isolated and used pyocyanase.

No serious work was done until Fleming (1929) described the action of Penicillium notatum. This discovery initiated a period of intense research, and in 1946, when the deep culture methods of production were developed, "Penicillin became obtainable for all."

Up to date, 130 other antibiotics have been described and 3,000 papers by 4,000 authors published.

At first it was understood that the effect of penicillin depended on the maintenance of its bacteriostatic level in the blood stream for a sufficient time, and thus aqueous solutions had to be injected at 3- or 4-hour intervals.

Recently, penicillin has been extensively used as a suspension in arachis oil containing a small proportion of bees-wax or of procaine penicillin, leaving in the tissue a depot of supply when inoculated; but Bigger (1944) found that the amounts of penicillin demonstable in the blood have been insufficient to explain its therapeutic effect.

Jawetz (1946), White, *et al.* (1946), and Zubrod (1947) showed that when infected with streptococci or pneumococci the duration of laboratory experimental animals survivals depends more on the total dose of penicillin injected than on the interval between injections.

Tillet, *et al.* (1944), treated pneumonia with success using large doses of aqueous penicillin at intervals of 12 or 24 hours.

Florey, *et al.* (1946), reported that when penicillin was injected after severe tissue damage it could be detected in the wound much longer than in the blood.

I. Ungar (1950) produced local œdema in guinea-pigs and rabbits by injecting small amounts (0.5 ml.) of oil of turpentine. He injected penicillin intramuscularly 48 hours later.

Ungar experiments proved that this penicillin remained in the fluid of damaged tissues for about twice as long as in the blood stream, and that single massive doses of penicillin were to be preferred because of the prolonged accumulation of penicillin in the inflamed tissue.

Streeten treated tuberculous arthritis by intra-articular inoculation of 0.25 to 0.5 gram streptomycin daily for ten days. Before the streptomycin inoculation, he raised the pH of the synovial fluid to 9, optimum for streptomycin action, by inoculating 10-20 ml. N/20 NaOH and a buffer M/20 borax in same amounts.

Galland, using streptomycin in 40 cases of skeletal tuberculosis, found it also successful in treatment of sinuses when combined with penicillin to counteract sepsis. Patients with chronic suppurative lesions and advanced amyloid disease should no longer be seen in surgical wards.

Surgical interference is essential to remove dead tissues before antibiotics can reach lesions and act.

As reported by Douglas (1950), unfortunate happenings may take place and contamination of needles or antibiotics may occur, and thus supports his theory that a mixture of both streptomycin and penicillin is a safeguard, besides fortifying antibiotic action.

Hirsh and Taggart (1948) treated 18 patients against soft sore, Durcey's bacilli infection, with doses of 0.5 to 1 g. daily. The sores healed in from 5 to 25 days.

Finally, Long and co-workers (1950) give a vivid picture on the clinical use of antibiotics available to date.

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Besides penicillin, streptomycin, polymyxin D., aureomycin, chloramphenicol (chloromycetin), terramycin and neomycin, other effective antibiotics will be discovered.

Toxicity.—The majority of antibiotics when used in heavy doses produce renal damage.

Bacterial resistance to antibiotics is important and must be guarded against.

Antibiotics in Use

Polymyxin D. and neomycin are not discussed as they are not available to the public because of their organic toxic properties. All antibiotics have proved *poisonous to some patients* and should be used with care.

Streptomycin and dihydrostreptomycin may cause permanent vestibular dysfunction and/or deafness, and their use should be limited to the treatment of tuberculosis. (The author found that dihydrostreptomycin in small doses, 1/4 or 1/5th of a gram mixed with 200,000 units of penicillin, and administered every 6 hours, to be less toxic and most effective.)

Aureomycin and terramycin were found to be less toxic, except for the inconvenience of nausea, vomition, sore mouth and diarrhœa.

Chloraphenicol is known to cause granulocytopenia.

Antibiotics are useful in certain animal diseases, both as a curative and as a protective for contacts.

Stableforth and co-workers (1949) eradicated mastitis due to *Str. agalectine* in a herd, using 5 doses of 100,000 units of penicillin at daily intervals.

Spencer and Kraft (1948) used penicillin in the treatment of chronic bovine mastitis.

Goret and co-workers (1948) treated cases of anthrax in cattle with penicillin.

Torrens and Wood (1949) cured these cases of actinomysosis, using streptomycin in 2 gram daily doses, within 3 months.

Morcos (1945) tried penicillin in various veterinary diseases. It proved specific to equine strangles, and 6 months following the last outbreak in Egypt of equine African horse sickness, two sporadic cases developed horse pest, and 500,000 units every 4 hours for 5 days helped complete recovery. This is reasonable, as serious trouble results from secondary organisms invading animal body tissues exhausted by viræmia. The two pest cases had neurotropic mouse vaccine 7 months before appearance of symptoms. Finally Preisz-Nocard bacilli infections responded most successfully to penicillin.

Experimental

Being an honorary bacteriologist to the Cairo Coptic Hospital since 1928, I suggested to Professor Shafik Shalaby, F.R.C.S., Professor of Surgery, Faculty of Medicine, Kasr el Eini, and Surgeon of the Coptic Hospital, that streptomycin and penicillin should be mixed together before inoculation for the following reasons:—

(a) Smaller doses of streptomycin may possibly be used for individuals sensitive to it.

(b) The possibility of fortification of antibiosis and saving a quantity of both antibiotics, as well as also a saving of labour.

Professor Shalaby, without hesitation, approved, and demanded laboratory evidence of fitness and potency of mixture before use *in vivo*. This was early in October, 1949.

In Vitro

(1) One-sixth of a gram of dihydrostreptomycin sulphate in 1 c.c. of sterile saline added to 10 c.c. broth culture of 48 hours' old of *B. coli*, incubated for 24 hours then subcultures on broth and plates of agar media proved *sterile* after incubation for 3 days.

(2) Experiment repeated using 3 broth cultures of *B. coli* inoculated and incubated for 48 hours—

to tube (a) 1/50 of a gram of streptomycin was added
" " (b) 1/25 " " "
" " (c) 1/12 " " "

Result:—

(a) Tube (a) subculture proved 50 per cent growth, that is, 1/50 of a gram was not sufficient to destroy in 48 hours 10 c.c. broth culture of *B. coli*.

(b) Tube (b) subculture proved 10 per cent growth (colonies) on agar plates.

(c) Tube (c) subcultures proved sterile.

Average dose to kill a 48 hours' broth culture of *B. coli* was between 1/25 and 1/12 of a gram of streptomycin.

(3) Experiment 3 as in 2, except *B. pyocyaneus* was used. Result: *The very same as in* 2.

(4) Penicillin, 50,000 units in 1 c.c. sterile saline, added to 10 c.c. 48 hours old broth culture of *Staphylococcus aureus*, incubated for 48 hours, the subcultured plated, using sterile glass rod, incubated for 3 days with negative result (no growth).

(5) Same as in 4, *Staph. aureus*, but 3 culture tubes were used to—

tube (a) 1,000 units pencillin aqueous was added
" (b) 5,000 " " " " "
" (c) 30,000 " " " " "

Result: 1,000 units failed to destroy all the culture, while 5,000 and 30,000 units subculture plates proved sterile.

(6) One-sixth of a gram of streptomycin in 1 c.c. sterile saline was added to 50,000 units of aqueous crystalline penicillin.

Result: On mixing and shaking, *no* physical or apparent chemical change took place—no cloudiness, no change in colour, no flocculation or any precipitation, the mixture was perfectly homogenous, and almost transparent.

This mixture was left in an ice-box (temperature 12° C.) for 3 days, then added to 48 hours' old broth culture, 10 c.c. of both *B. coli* and *Staph. aureus*, 5 c.c. each, incubated for 24 hours, then plated; plates *sterile* after 48 hours' incubation.

XUM

(7) One-fiftieth of a gram of dihydrostreptomycin sulphate in 1 c.c. sterile saline added to 1,000 units penicillin then mixed with 48 hours' old mixed broth culture of *B. coli* and *Staph. aureus*, incubated for 24 hours, then plated and incubated for 48 hours.

Result: 50 colonies appeared.

(8) Same as in 7, using 1/25 gram streptomycin and 5,000 units of penicillin.

Result: Subculture negative, sterile.

(9) One-twenty-fifth of streptomycin added to 5,000 units penicillin with 1 c.c. saline added to 10 c.c. 48 hours' old broth culture of *B. pyocyaneus*.

Result: Plating negative, sterile.

Summary

In vitro addition of dihydrostreptomycin and aqueous crystalline penicillin does not interfere with their antibiotic action; *on the contrary, the antibiotic effect is accentuated, being almost doubled.*

In vivo.—Professor Shalaby said: " Please report that, during the last ten months. in all surgical cases where streptomycin and penicillin are indicated, both antibiotics were mixed before inoculation and proved most satisfactory."

One particular case is worthy of report. A male patient was often treated endoscopically, and between the 7th and 17th day of treatment developed orchitis—on one occasion whilst taking sulphonimides and on another penicillin and sulphonamides (*B. pyocyaneus* was isolated from the urine). Since this patient was given a mixture of 1/5 of a gram of dihydrostreptomycin added to 100,000 units penicillin in 1 c.c. saline every 6 hours and for 10 days, not only orchitis did not develop. but no discomfort or pain was experienced in the pelvic organs.

Thus, for streptomycin-sensitive patients, a mixture of both streptomycin and penicillin is tolerated well and a better effect may be expected.

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SOME RECENT ADVANCES IN THE GENERAL ANÆSTHESIA OF THE DOG*

PART III

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The Use of the Tube as an Airway.

The opinion has often been expressed, recently by Schnelle (quoted by Gadd, 1948), Knight (1949) and Freak (1949), that a frequent cause of otherwise unaccountable anæsthetic death is the closure of the natural airway of the pharynx. It is suggested that this is most commonly occasioned by the tongue falling backwards, so that the epiglottis covers over and occludes the upper laryngeal opening. The difficulty of maintaining safe anæsthesia in the brachicephalic breeds (the bulldog, French bulldog, Boston terrier, pug, and to a lesser extent the boxer, cavalier and King Charles spaniel) has long been recognised. There is little doubt that this is due to the antero-posterior compression of the pharyngeal morphology in these breeds, which renders the danger of laryngeal occlusion greater.

The introduction of an endotracheal tube to act as an airway, however, almost entirely eliminates this risk. It is impossible to overstress the importance of this use of the endotracheal tube, as a safety measure to accompany the administration of deep anæsthesia for any purpose whatever. The tube should be introduced immediately sufficient depth of anæsthesia has been achieved, especially in the case of the brachicephalic breeds. If intubation is delayed in these breeds, the animal may be dead before the operation has commenced. The tube should be left in position until the animal has recovered from the anæsthesia sufficiently to object to its presence.

Endotracheal Anæsthesia.

As stated above, the endotracheal tube can also serve as a route for the introduction of an inhalant anæsthetic mixture directly into the trachea. Using this method, the use of the open or closed mask is eliminated.

Endotracheal anæsthesia has been employed for many years for experimental surgery, and to a lesser extent for clinical surgery in the U.S.A., but although the technique has been described recently by Gregory (1947) and by Wright (1947), it does not yet appear to have been adopted to any extent in general practice in this country. Intubation also serves as a means of ventilating the lungs for the performance of intrathoracic operations, and a description of its use for this purpose will be found in the following Section.

The advantages of this method of anæsthesia over the use of a mask have been listed by Gadd, and include the following:—

(1) A clear airway is ensured throughout the anæsthesia.

*This work was done whilst the author was holding a Research Training Scholarship from the Animal Health Trust.

(2) Better oxygenation is achieved, and if cyanosis should occur, rapid oxygenation can be carried out more efficiently.

(3) Anæsthesia can be maintained more evenly and the animal seems to recover more rapidly.

(4) There is less waste of the anæsthetic mixture, and less escapes to affect the operator.

(5) The endotracheal tube serves as a means of providing positive pressure ventilation of the lungs if natural respiration should cease. This may occur as a result of either the depression of the nervous mechanism controlling respiration, or of the pneumothorax which follows penetration of the thoracic wall.

Two methods may be employed for routine endotracheal anæsthesia: (1) Insufflation anæsthesia, and (2) auto-inhalation anæsthesia.

Insufflation Endotracheal Anæsthesia.

By insufflation anæsthesia is meant the continuous blowing of a gas mixture into the trachea under low pressure (20 to 30 mm. mercury [Dinsmore, 1947]). The mixture is then drawn into the lung alveoli, and later expelled, by the natural movements of respiration.

The insufflated anæsthetic mixture may consist of any combination of the following: Air, oxygen, CO_2, nitrous oxide, and the vapours of ether, chloroform, and trilene. If only non-volatile agents are to be used, the cylinders are connected via a reservoir bag or bottle to the outer end of the endotracheal tube. If one of the volatile vapours is also to be used, the gas mixture is passed through either a Wright's bottle, Woulff's bottle (Gadd), Boyle's bottle (Fig. 5), or through a system of bottles such as that described by Longley (1947), where it is passed over, or bubbled through, the ether, chloroform, or trilene.

Alternatively, if only air is to be used in conjunction with a volatile vapour, a small air pump, such as the electric pump designed by Hobday (Fig. 6), or that employed by Gadd, may be used to blow the air through to the tube.

The original method of insufflation anæsthesia was that described by Meltzer and Auer in 1910, modified and improved by Livingstone and Hrdina in 1930, and again by Gadd in 1939 and 1948. This method consists of the insufflation of the anæsthetic mixture through a narrow-bore endotracheal tube (a catheter was commonly used), the gases escaping to the exterior around the outside of the tube.

Considerable disadvantages have been reported with this method by some authors. There is a continuous waste of anæsthetic mixture which affects the operator. Spasm of the vocal cords, which partially closes off the escape of the gases, is common. The escape of the gases is also likely to become blocked by the collection of debris around the tube. And there is nothing to prevent the inhalation of fluids around the tube.

Various modifications of this technique have been designed to overcome these disadvantages. Brown-Scott and Rudolph introduced a series of wide-bore, metal endotracheal tubes which carried narrower inlet tubes in their centres. Whilst these tubes would seem to be ideal in theory, they do not seem to have found wide usage.

Most authors now report more favourably on one or more of the various techniques of auto-inhalation anæsthesia.

Auto-inhalation Endotracheal Anæsthesia.

This method involves the use of a wide-bore endotracheal tube, through which the animal inhales the anæsthetic mixture by its own natural respiratory efforts. It is possible with this technique to arrange for any required degree of rebreathing to take place.

By rebreathing is meant the use of a system whereby a part or the whole of the exhaled air is rebreathed in the following inspiration. The advantages of such a system comprise the conservation of the anæsthetic mixture and the heat and moisture in the exhalation, and the accumulation of CO_2, which acts as a stimulus to respiration.

The degree to which rebreathing takes place is governed by the provisions which are made for the escape of the exhaled air. If an expiration valve is situated immediately at the union with the endotracheal tube then rebreathing will be minimal and will be limited to the volume of air contained within the tube. Such an expiration valve may be adjustable, however, from fully open (minimal rebreathing) to closed (100 per cent rebreathing).

If the expiration valve is not adjustable, the degree of rebreathing can be increased by increasing the length of the connection between it and the tube.

If the expiration valve be substituted by a "rebreathing bag" which will contain the exhaled air, then 100 per cent rebreathing will occur and the system is known as a "closed circuit." With such a closed circuit, however, some provision must be made for the partial removal of CO_2, which would otherwise accumulate to a toxic concentration. This may be achieved in two ways: (1) The bag may be periodically removed and emptied, but this has the disadvantage of submitting the animal to a varying CO_2 concentration. (2) A canister of soda-lime, which acts as a CO_2 absorber, may be included in the circuit.

Auto-inhalation anæsthesia was first introduced by McGrath (1914), whose method was modified by Mann (1920), and again by Hardenburgh and Mann (1927). More recently the subject has been dealt with by Schlotthauer (1937 and 1949) and Dinsmore (1947 and 1949).

The technique recommended by Dinsmore employs a completely closed circuit. Oxygen from a cylinder is passed through an ether vapouriser, and led directly to the union with a rubber Magill tube. At this union is also attached a 3-litre rebreathing bag. This bag acts as a reservoir, from which,

and into which, the animal breathes the anæsthetic mixture. Overdistention of the bag and the development of excess pressure is controlled by a relief valve at its mouth.

To quote Dinsmore: ". . . . an excess of CO_2 develops. This is not usually considered harmful, particularly in a concentration of 5 per cent or less, and has a definite advantage as a respiratory stimulant. However, where a soda-lime CO_2 absorber is not used the rebreathing bag should be emptied at intervals to prevent over-stimulation of the respiratory centre by excessive CO_2 accumulation."

Schlotthauer has described the technique adopted for the endotracheal anæsthesia of dogs at the Mayo foundation. It is based on the original method of McGrath, and consists essentially of the use of a brass endotracheal tube, which does not fit into the trachea too tightly, and which leads to a brass T-piece. Each arm of the T-piece carries a hand-operated sleeve-valve, one arm is closed at the end, and the other is connected to the outlet of an ether can. (Fig. 7.) Operation of the valves admits air to dilute the ether-laden vapour entering the trachea. Inspiration and expiration occur: (i) Through the ether can; (ii) through the valves when open; and (iii) around the endotracheal tube.

13. Anæsthesia for Intrathoracic and Cardiac Surgery

Surgical conditions requiring thoracotomy, or the opening of the thoracic cavity, whilst not common in the dog, are met with from time to time in general practice. In order to be able to manage these cases, it is essential to understand the special problems of anæsthesia and lung ventilation involved in this procedure. Markowitz (1949) has said: "In our student days intrathoracic surgery sounded very mysterious and formidable. We know to-day that it need not be so." And this is indeed the case, for once the technique has been mastered, the opening and closing of the thoracic cavity can be as simple as laparotomy.

Nor is the procedure of thoracotomy a new one. Rolandus is reported to have performed pneumectomy "for the cure of diaphragmatic hernia" in 1492, and Schenk to have aroused interest in intrathoracic surgery early in the 16th century (Murphy, 1898). Livingstone and Hrdina (1930) report that Milton used endotracheal insufflation anæsthesia for an intrathoracic operation on a goat, and another on a human, in 1897, and state further that methods for the artificial inflation of the lungs date back to Hippocrates and Paracelsus (1493-1541). These authors have prepared an excellent account of the methods of anæsthesia and lung ventilation for lung and other intrathoracic operations, and of the other uses of endotracheal insufflation anæsthesia, up to 1930.

Little advance has been made in the basic technique for the artificial inflation of the lungs for thoracotomy in the dog during the last 20 years.

The Indications for Thoracotomy in the Dog.

(1) Exploratory Thoracotomy.

(2) Surgery of the Diaphragm.

Congenital anomalies of the diaphragm, both repairable (congenital hernia, Stewart [1929]), congenital defect (Larsen and Ottosen [1939]), and irreparable (congenital absence, Schnelle [1941]) have been reported. Traumatic rupture of the diaphragm is far more common, and is undoubtedly the most frequent indication for thoracotomy. Cases have been reported by Brook and Holmes (1929), who collated all reported cases to that date, Schneider (1934), Schnelle (1939), Necheles and Olson (1942), Garlick (1945), Blakely and Munson (1945), and Knight (1948), amongst many others.

The cases reported by Vigue (1947) and Sealy (1950) stress the need for surgical repair of such traumatic lesions, even though the animal makes an apparent recovery at the time, for adhesions which form at the time are liable to break down at any time in the future, with rapid death as the possible result.

A few attempts at repair by the abdominal route have been reported, with unhappy results in some cases (e.g., Chambers, 1924) and more successful results in others (e.g., Blakely and Munson, and Garlick). The majority of operators who have experienced both the abdominal route and the thoracic route for this operation agree that in most cases the latter is the more convenient.

(3) Surgery of the Œsophagus (Thoracic Portion).

The occurrence of foreign bodies in the thoracic portion of the œsophagus has frequently been reported, recently by Schnelle (1940), Oudot (1942), and Hodgman (1944). Such foreign bodies are often extremely intractable, and are more easily and more safely removed by thoracic œsophagotomy than by any other approach.

Thoracic œsophagectomy for the excision of malignant tissue in this portion of the œsophagus in the dog is a procedure which is still in the experimental stages, but which will no doubt make its appearance in clinical surgery in the near future.

(4) Removal of Intrathoracic Foreign Bodies.

Knight, *et al.* (1945) have reported on the surgical removal of a bullet from the chest of a dog.

(5) Excision of Intrathoracic Neoplasms.

This again is a procedure which has yet to make its appearance in clinical surgery. Intrathoracic neoplasms have been reported in the dog, however (e.g., Viergutz, 1942), and the excision of such tissues now seems a possibility.

(6) Cardiac Surgery.

Surgical interference with the heart and great vessels has for a long time been common practice in the experimental surgery of the dog, and, in 1936, O'Shaughnessy and McCunn recorded two successful operations for the relief of pericardial tension in greyhounds. The possibility of the surgical closure of the patent foramen ovale in the dog was speculated in the U.S.A. in 1948, following the report of this condition at Alfort by Thiéry (1947). With this must be coupled the possibility of the surgical correction of the persistent ductus

arteriosus, such as reported by Hare and Orr (1931), and other anomalies, such as reported by Davies and Ottaway (1943) and Hare (1943). It is of interest to note the bold attempt of Coop (1947) to remove surgically adult filaria from the heart of an English setter.

The Problem of Lung Ventilation for Thoracotomy.

It will be seen from the foregoing remarks that the indications for thoracotomy in the dog, whilst not of everyday occurrence, are perhaps common enough to warrant a consideration of the technicalities involved, for it is certain that this procedure is to become more general in the future.

The problem is simple: "In the dog, even a small puncture of one pleural cavity . . . . will cause fatal collapse of both lungs. This is because the anterior mediastinum of the dog is very flimsy and yields or tears when one lung collapses, allowing the other pleural cavity also to fill with air. The dog has only one chest, and surgery of the dog's thorax can only be performed under positive pressure ventilation through the trachea." (Markowitz.)

Thus the difficulty in intrathoracic surgery is to provide by some artificial means adequate ventilation and oxygen supply to the lung alveoli. Two methods have been employed: (1) Insufflation, and (2) controlled artificial inflation.

Insufflation.

The technique for insufflation anæsthesia for intrathoracic surgery differs in no important respect from that described in the preceding section for the anæsthesia of the animal with an intact thorax. A fine-bore endotracheal tube or a catheter is introduced into the trachea and passed down as far as the bifurcation. Through this tube is introduced oxygen, or a mixture of oxygen with air, ether, nitrous oxide, etc. Ventilation of the alveoli and respiration occurs by diffusion, and possibly also to a small degree by the to and fro movement of the gases occasioned by the movement of the beating heart. The gases can escape around the outside of the insufflation tube to the exterior.

The case quoted above of Milton (1897) is no doubt one of the earliest records in the history of veterinary surgery of a thoracotomy performed under endotracheal insufflation anæsthesia. By 1930, Livingstone and Hrdina reported perfect anæsthesia in 1,000 operations, including 900 thoracotomies, using a modified Meltzer and Auer insufflation technique. Two of their cases were kept under for 13 hours each. The intratracheal pressure could be adjusted in their apparatus by means of an outlet tube which was immersed to a variable depth in a water jar, so that the lungs were kept permanently inflated to about half of their normal maximum size. The gas pressure in the supply was kept at between 2 and 4 cm. mercury pressure. They reported good results with oxygen-ether mixtures, but found chloroform very irritant when used by this method.

Insufflation anæsthesia for thoracotomy has now become largely replaced by the more satisfactory methods of controlled artificial inflation, and recent reports of this method in the literature are consequently few.

XUM

Controlled Artificial Inflation.

Controlled artificial inflation consists of the rhythmic inflation of the lungs with an oxygen, or oxygen and ether, etc., mixture, the lungs being allowed to collapse under their own recoil between inflations.

For this procedure it is obviously desirable to have something approaching an airtight union between the gas supply and the trachea. A wide-bore Magill tube which fits snugly into the trachea may suffice for this purpose. In the U.S.A. metal endotracheal tubes are more popular, and Secord advocates the use of a brass tube. The most satisfactory tube, however, is the cuffed Magill tube, which consists of an ordinary rubber Magill tube with an inflatable (Guedel-Waters) rubber cuff at the lower end. This cuff is inflated after the tube has been introducd into the trachea, via a small side tube which carries an indicator bulb (Fig. 8). The cuff may be inflated with air or water. When in position, the cuff should be just below the larynx, where it will grip tightly, prevent the tube from slipping out, prevent foreign bodies and vomitus from entering the trachea, but also it will prevent the upward egress of bronchial secretions. Thus premedication with atropine is indicated when this tube is to be used. The outer end of this tube can easily be connected to the gas supply, and for this purpose the Cobb suction union (Fig. 9) will be found convenient. There should be an expiratory valve or side-arm for expiration immediately at this connection, in order that the dead space in the system may be kept as low as possible.

Many methods have been used to bring about the inflation of the lungs:—

(1) A car tyre pump has been used with success by many operators; Schneider, Blakely and Munson, and others. But this method obviously involves the constant attention of an assistant, and consequently many types of automatic power-driven pumps have been constructed.

(2) Automatic power-driven respiration pumps draw in a variable volume of gas (air, or a gas mixture from a bag), which is then forced into the lungs at the same time as the expiration valve is closed. Then, as the machine is filling itself with the air or gas which is to form the next "breath," the expiration valve is opened and the lungs collapse under their own recoil.

Thus the use of the "Tiegel-Henle positive pressure apparatus" was described by O'Shaughnessy and McCunn, and of the "Robinson respiration pump" by Secord. A satisfactory and very convenient machine which has been used by the author with complete success in a series of over 50 experimental thoracotomies is a modification of the original Starling's pump. (Fig. 10.) This pump can be adjusted to deliver any volume up to 500 c.c. at any frequency. A frequency range of from 10 to 20 respirations per minute will be found suitable for all normal operative procedures. This pump has been found to inflate the lungs satisfactorily at approximately 13 mms. mercury pressure, and expiration then occurs at approximately 5 mms. mercury pressure. Such pressures are well within the safety limit of intrapulmonary pressure (Gerbode, *et al.*, 1950).

(3) An alternative method is to achieve the inflation from a supply of compressed air, oxygen, etc., in place of the pump. The pressure supply must, of course, be interrupted intermittently and regularly, and some expiratory outlet opened, in order that the lungs may collapse between inflations. In order to do this, two methods have been employed.

The supply of compressed gas may be connected via a reservoir bottle to the cuffed tube, and at the tube connection there is a side arm. When the side arm is closed, the pressure directly inflates the lungs. When it is opened, both the gas from the bottle and the exhaled air escape through the side arm together.

The disadvantages of this method are that about twice the volume of air or gas which is actually needed is used, and that when the side arm is closed there is a brief latent time whilst the pressure in the system builds up again before inflation recommences.

Alternatively, the cylinder may be connected via a small rubber bag to the inspiration arm of a Y-piece attached to the cuffed tube, the third arm of the Y-piece becoming the expiration arm. The rubber bag is filled, and the gas supply is set to about half the rate of flow required in the previous method. Then, with the inspiration arm open and the expiration arm closed, the pressure from the bag inflates the lungs. At the required moment the inspiration arm is closed, so that the pressure is cut off from the lungs but builds up again in the bag, and the expiration arm is opened so that the lungs are free to collapse and exhale to the open air.

It will be appreciated that with this method no gas is wasted and there is no lag before inflation recommences when the inspiration arm is again opened.

The opening and closing of the arms in either of these methods can be performed by hand or mechanically, e.g., by a simple system of rotating eccentric cams. The mechanical method has obvious advantages, especially if one is short-handed, but the hand-operated system has the advantage that the anæsthetist is obliged to maintain a constant vigil over his patient and can vary the degree of inflation and the rate of respiration at will. Human anæsthetists have almost completely dropped the use of mechanical methods of lung inflation in favour of hand-operated systems largely for this reason.

The General Procedure for Thoracotomy.

It is not proposed to deal with the surgical methods at present employed in thoracotomy in the dog; the techniques have been well described by Markowitz, and the methods employed for diaphragmatic repair have been described by Secord, Knight (1948) and others. The human text-books of intrathoracic surgery can also be consulted to advantage on this subject. Suffice here to say that the thoracic wall of the dog may be opened with equal facility by rib resection or by the intercostal route, depending on the degree of exposure which is required.

PLATE I

MS64 [*From Messrs. A. Chas. King, Ltd.*

FIG. 4.—Magill Endotracheal Tube in mineralised rubber.

FIG.5

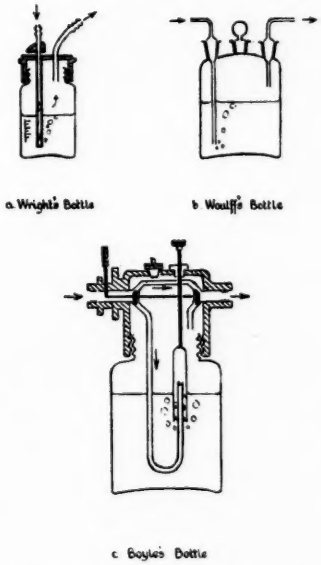


FIG. 5.—Diagrammatic representation of the Wright's bottle, Woulff's bottle, and Boyle's bottle, as used for inhalation anæsthesia.

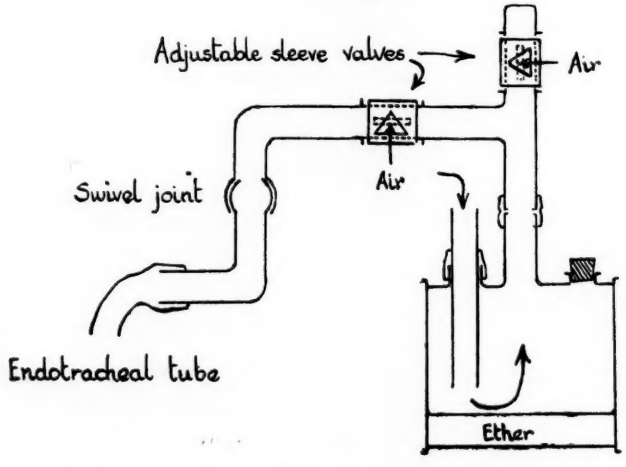
(*Article by N. Comben page* 427)

PLATE II

[*From Messrs. Arnold & Sons.*

FIG. 6.—Hobday's Electric Anæsthetic Pump.

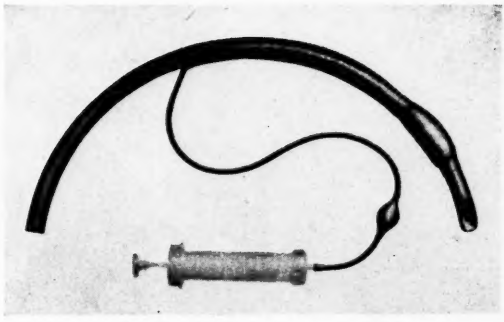
FIG.7



The Ether Can System

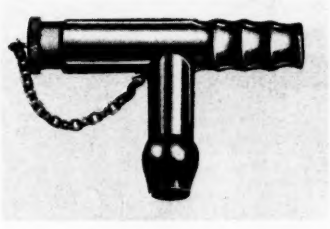
FIG. 7.—The Ether Can circuit as employed at the Institute of Experimental Medicine of the Mayo Foundation, Rochester, Minn. Redrawn from Schlotthauer (1949).

(*Article by N. Comben page* 427)



[*From Messrs. A. Chas. King, Ltd.*

FIG. 8.—Magill Tube with Guedel-Waters Cuff.

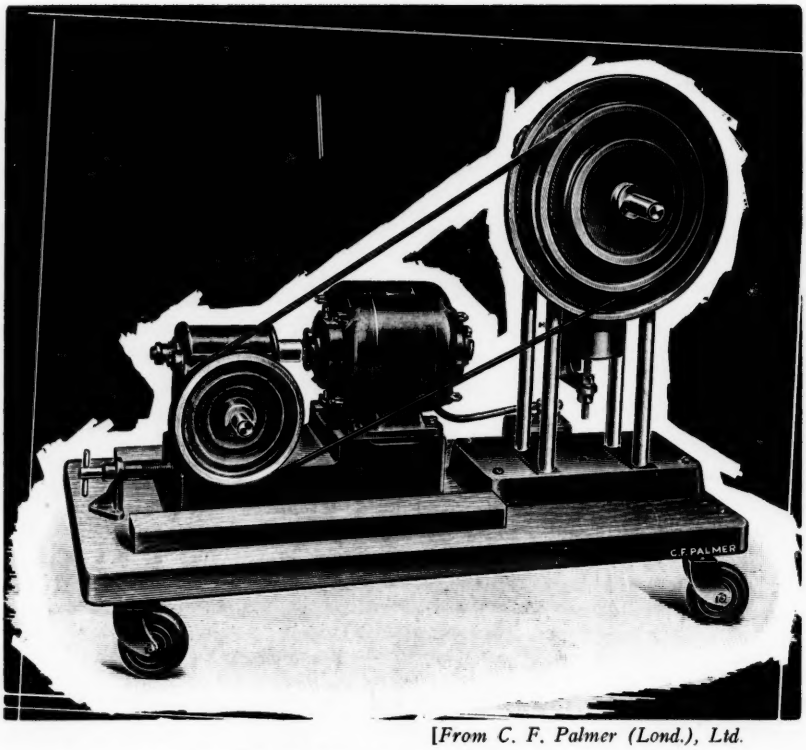


[*From Messrs. A. Chas. King, Ltd.*

FIG. 9.—Cobb Suction Union.

(*Article by N. Comben page* 427)

PLATE IV



[*From C. F. Palmer (Lond.), Ltd.*

FIG. 10.—Palmer's "Ideal" Pump Assembly—a modification of the original respiration pump designed by Starling.

(*Article by N. Comben page* 427)

It is essential that before an animal is submitted to thoracotomy, as before any other operation, its general condition be built up to as high a level as is compatible with the surgical condition concerned. The animal presented with a ruptured diaphragm has usually been in this condition for two or three days whilst the practitioner has been confirming his diagnosis. The majority of such cases, whilst in some degree of respiratory distress, are capable of oxygenating themselves reasonably well. Unless such a case shows extreme respiratory distress, and is becoming cyanotic, it should not be submitted to thoracotomy within a few hours of the causal accident. At such time the animal is usually suffering a severe degree of shock, and the addition of immediate surgical shock may well be sufficient to bring about its death. It is usually safe to assume that if the animal has survived the rupture of its diaphragm for the first few hours after an accident, then it can survive for as many days, and that it will be to its distinct advantage to wait a few days before operating. Blakely and Munson recommend waiting for from 7 to 10 days whenever possible before attempting a diaphragm repair. The same remarks apply to the animal with a bullet or other foreign body in the thorax.

In the case of the thoracic œsophageal foreign body there is again no need for immediate operation in the majority of cases unless radiographic examination demonstrates that there is danger of perforation.

Treatment during the days preceding thoracotomy should be guided in the following directions:—

(1) General nursing and feeding to build up the animal's bodily condition, resistance to infection, and to overcome the shock resulting from the causal accident. Maintenance, or correction, of the fluid balance of the body (see the following section).

(2) Medication according to symptoms, but particularly directed towards the relief of any pathological condition of the respiratory tract and the elimination of as much bronchial secretion as possible.

(3) Treatment with large doses of penicillin, to provide a "penicillin umbrella" under which to operate. The pleura is extremely susceptible to infections.

(4) Premedication before the anæsthetic with atropine to eliminate bronchial secretions.

The Choice of Anæsthetic Agent.

The special considerations governing the choice of an anæsthetic agent for thoracotomy in the dog are as follows:—

(1) The operation will probably be prolonged.

(2) Unless a positive pressure pump is being used, it will be difficult to introduce a volatile anæsthetic agent into the system during the operation.

(3) There will be no natural respiratory movements to act as a guide to anæsthetic depth during the operation.

(4) Respiratory depression is not a serious consideration since the artificial respiration apparatus will be available from the start should this stage be reached.

(5) The heart will be working in abnormal conditions of surrounding pressure, and will probably receive numerous mechanical stimuli during the operation, so that any anæsthetic agent which affects the heart adversely should be avoided.

Thus it will be seen that pentobarbitone (" Nembutal ") is the anæsthetic of choice for the majority of intrathoracic operations. Alternatives are intermittent thiopentobarbitone (" Pentothal "), administered, if possible, through a saline drip, or thiopentobarbitone with ether and/or nitrous oxide and oxygen if a positive pressure pump is to be used. Chloroform, cyclopropane, and trilene are contra-indicated on account of their adverse action on the heart.

Using a barbiturate anæsthetic the animal can be induced slowly to a deep plane approaching that of respiratory failure. It is then intubated quickly and connected immediately to the artificial respirator. In this plane its natural respiratory impulses will be feeble and it will quickly accept the rhythm of the respirator. Having had a maximal dose of the barbiturate, anæsthesia will be maintained for a long time. With pentobarbitone the first dose will last in most cases for two or three hours, which is well beyond the time required for the average thoracotomy. It is seldom that a dog so anæsthetised shows any signs of lightening anæsthesia during the course of the operation.

The Routine for Lung Ventilation.

It is essential to ensure at all times that the alveoli are sufficiently oxygenated by the artificial respiration, but regular inflation with air will be adequate in most cases. An air/oxygen mixture will be an advantage in anoxic patients, or even pure oxygen in the severely cyanosed patient and at moments of crisis, but under no circumstances should a dog be respired on pure oxygen throughout the course of the operation. A dog so treated will become so overoxygenated that extreme difficulty will be experienced in stimulating natural respirations at the end of the operation when the respirator is disconnected.

A tidal air of between 200 c.c. and 600 c.c. will be required, according to the size of the dog.

When the thorax is opened, at the moment the parietal pleura is penetrated there will be an inrush of air and the lungs will collapse. When this opening is enlarged the lungs may be watched, and it is at this time that the anæsthetist should adjust the respirator to that setting which he considers will suffice throughout the operation. In most cases a setting which permits of inflation of the lungs to about half of their normal maximum size, about 12 or 15 times per minute,

XUM

will prove satisfactory and will not produce such intrathoracic movement as to hinder the surgeon.

After the operation, the next duty of the anæsthetist will be to supervise the reinflation of the lungs when the chest wall is again made patent. This is done as follows: The animal is left until the surgeon has completed most of his first layer of sutures through the parietal pleura and the muscle. The final suture in this layer is placed in position, but not tied. The anæsthetist now disconnects the endotracheal tube from the respirator and blows through this tube with his own lungs until the surgeon can see that the dog's lungs are inflated to the maximum size that can be contained within the thorax. He then quickly ties his last suture, and a reasonable negative pressure will have been restored to the thorax.

The dog should now be capable of spontaneous respiration without the aid of the respirator, and many will immediately commence respiration on their own, but as a rule it is safer to reconnect the dog to the respirator whilst the surgeon completes the sutures in the thoracic wall. In most cases the dog will, in fact, have been overventilated throughout the operation, and the stage is now being reached when all somatic stimuli from the operative site will cease. These two factors combine to make the initial respiratory efforts of the dog after the operation very feeble and uncertain, and this is frequently the most worrying time for the anæsthetist.

Thus it is safer to leave the dog connected to the respirator until the surgeon has completed the operation. During this time the ventilation may be decreased in both rate and tidal volume, so that the dog will not be too overventilated. When the respirator is finally disconnected after this routine, spontaneous respiration usually commences within 30 seconds. If this is not the case, a respiration may be provoked by a somatic stimulus such as pinching or slapping a skin area (especially in the region of the diaphragm), by gentle pressure on the thoracic wall, by gently agitating the cuffed tube, or by introducing a little CO_2 into the lungs. If still no respiration is forthcoming, the tube should be reconnected to the respirator for a short while before the dog is allowed to try to respire on its own again. Providing there is a good pulse there is no real danger at this stage, for the dog can be left connected to the respirator for any length of time until it has recovered from the anæsthetic sufficiently to respire on its own. One must never forget, however, to exert a constant vigil on the heart and pulse rate of an artificially respired dog to ensure that the animal is, in fact, still alive.

When spontaneous respiration commences and is satisfactory, the cuff of the endotracheal tube may be deflated, but the tube should be left in place until the animal will no longer tolerate it, so that it may act as an airway during the early recovery period.

The post-operative requirements of warmth and replacement of fluid loss are both especially important after thoracotomy, for a large measure of both of these commodities will have been lost from the open thorax.

XUM

14. The care of the surgical patient

Various aspects of the care of the surgical patient during the immediately pre- and post-operative periods, and during the actual operation, are tending more and more to become the responsibility of the anæsthetist. As such, they will be considered briefly as the conclusion to this paper.

Pre-feeding.

Before any operation the general condition of the animal should be raised to as high a level as is compatible with the nature of the causal conditions, always providing that its chance of survival is not in any way jeopardised by the postponement of the operation. The value of glucose in enhancing the glycogen reserves and powers of detoxication of the liver has long been appreciated. This factor is more important when chloroform or one of the barbiturates is to be used than when ether is to be the anæsthetic. But equally important is the pre-operative supply of protein. Many sources of digestible protein, such as meat or poultry extracts, are now available, and almost any form of protein which the animal is able to retain and digest is permissible. A very useful source is reconstituted powdered skimmed milk, which provides the required digestible protein without an excess of fat. The milk should be made up to double the normal strength and ideally should be supplemented with iron and vitamin C.

If during the illness preceding hospitalisation there has been insufficient replacement of protein in the animal, a condition of hypoproteinæmia may exist. This may result from actual starvation, impaired digestion or absorption of proteins, liver dysfunction, or from the prolonged loss of protein which occurs in continual hæmorrhages, etc. In advanced cases, œdema may be evident, and if the animal be operated upon the wounds will heal very slowly. Particular attention should be paid to the pre-operative supply of protein in these cases, and the operation postponed for anything up to two weeks.

With many surgical cases, prolonged pre-operative preparation is not possible, and any such treatment must be made within one or two days. The ideal treatment of such cases would consist of the use of a continuous drip feed of milk, etc., or of a continuous intravenous drip of plasma. But in practice it is not possible to use either of these methods for our unco-operative patients, and it is necessary to resort to the frequent feeding of small quantities of digestible protein or to the repeated intravenous injection of plasma or other compatible protein material.

It has been shown recently that nitrogen balance can be maintained in an animal by the direct intravenous injection of solutions containing mixtures of all the essential amino-acids or certain protein hydrolysates (Elman, 1944). This method has proved of great value in the protein feeding of human patients, and a protein hydrolysate preparation now available for veterinary use is giving the most encouraging results in small-animal practice.

If the hypoproteinæmia is complicated by true anæmia the requisite amount of whole blood should, of course, be administered in place of, or along with, the other fluids.

Premedication.

The indications and problems of premedication have been dealt with in an earlier section.

The Prophylactic Use of Antibiotics.

The advent of penicillin and the other antibiotics has made practicable many surgical procedures which were previously discarded on account of the high incidence of post-operative sepsis. Bone surgery, and surgery within the thorax, are the two most outstanding examples. For such procedures it is well to administer penicillin during 12 or 24 hours pre-operatively and for 1 to 3 days post-operatively.

The use of the antibiotics, however, must never become an excuse for the relaxation of any of the aseptic measures previously practised.

Fluid Balance.

The maintenance, or restoration, of the correct fluid balance in the tissues of the body of the animal before, during, and after every major surgical procedure, is, perhaps, second only to the actual surgical technique in deciding the success or otherwise of the operation.

Cases of true water depletion, the result of insufficient intake of fluids by the animal, are rare. Such cases must be treated with water alone and on no account given large volumes of saline.

Most cases of dehydration result from an excessive loss of fluids and electrolytes in the secretions and excretions of the animal, such as with diarrhœa, vomiting, etc. These cases involve the loss of both water and salts, and they deteriorate rapidly in condition. They must be treated with saline, and on no account given large volumes of water to drink.

Saline, or glucose saline, may be given by the intravenous, subcutaneous, or rectal routes, or the animal may be allowed to drink the solution. Again, the ideal method of administering the saline would be in a continuous intravenous drip, but this is only possible during the operation.

The value of a continuous intravenous drip of saline, glucose saline, plasma, or whole blood during a major surgical procedure cannot be overstressed. Especially is this the case with the very old or very debilitated patient, and the animal undergoing an operation where there is excessive hæmorrhage. In addition, the rubber tube of the drip feed affords a simple means of introducing adrenaline, etc., or intermittent doses of thiopentobarbitone when this is the anæsthetic of choice. The technique of this procedure for the dog has been

described by Phillips (1947), who advocates the use of a continuous drip of 5 per cent dextrose and 5 per cent alcohol in saline (Abbots).

The apparatus is simple. It must, of course, be sterile. A bottle containing the fluid to be introduced is inverted and hung a few feet above the animal; this bottle has an air inlet and an outlet connected by a rubber tube to a glass observation chamber. From here another tube leads directly to the needle, which is affixed in the vein. Adjustment of a Mohr's clip on the lower length of tubing regulates the flow as observed in the observation chamber.

The needle in the vein may be a short point, wide bore (serum) needle (Philips uses a 23 or 25 gauge needle), but an intravenous cannula will be found more satisfactory. The cannula is introduced into the vein with a trochar in position, the trochar is partially removed, and the cannula, now blunt, may be passed further into the vein without risk of damaging or penetrating its wall. The drip is then connected by a "Record" adaptor to the needle or cannula, and the union is strapped in position on the leg with adhesive plaster.

Animals which have suffered severe shock or hæmorrhage will require not only saline, but plasma or whole blood. The loss of plasma alone under certain circumstances can be more serious than the loss of whole blood, for hæmoconcentration occurs and the rate of blood flow diminishes as the viscoscity increases. A concentration of cells of from 5 to $7\frac{1}{2}$ million per cu. mm. will halve the rate of flow.

In all cases treatment should consist of the supply of whatever fluid has been lost. If it should be necessary to stock one fluid to be used for all cases, plasma would be the choice. When using blood or plasma, the blood volume should be restored to normal within 1 to $1\frac{1}{2}$ hours.

Warmth.

It is well known that under general anæsthesia the body temperature of an animal may drop as much as 7 degrees F. below normal, and the animal become appreciably cold. This is the result of both depression of the temperature regulating mechanism and the heat loss which occurs from the open thorax or abdomen, etc. The temperature drop is an integral factor in the syndrome of surgical shock, and artificial heat must be provided during the operation and the post-operative period. Many methods of applying warmth to the anæsthetised animal have been devised, from hot water bottles to the use of hot water tanks in the surface of the operating table. But none of these methods have proved as successful as the electrically heated blankets which have recently been introduced.

These blankets are connected via a transformer to the mains, and most offer a choice of temperature. They are very safe in use, are impermeable to fluids, and may be used on the operating table or in the kennel. They have now been used in a large series of both clinical and experimental operations with complete success.

The use of the "Wyndak" blanket has recently been described by Formston, *et al.* (1949), and Longley (1949). It is further reported by both of these authors that the time for detoxication of the barbiturates is considerably reduced when the electric blanket is used in the immediately post-operative period.

The Period of Anæsthetic Recovery.

Dangers associated with the period of recovery from anæsthesia are: (1) blockage of the natural airway, and (2) self-inflicted damage resulting from inco-ordinated movements.

The maintenance of patency of the airway by the use of an endotracheal tube has already been described. Such a tube should be left in position until the animal will no longer tolerate its presence, when it will usually be safe to remove it.

Self-inflicted damage may result from the inco-ordinated movements which invariably occur during the period of recovery from any anæsthetic, and for this reason a special "coming-round" pen should be available. Such a pen should be large enough to lay the animal flat on its side so that it may "paddle" without injuring its legs. The pen should have no ledges, steps, or projections, should have provision for artificial heating, and should have a soft floor and padded walls.

Pulmonary Complications.

A variety of post-operative pulmonary conditions may result from the many factors which influence pulmonary activity during the anæsthetic period. Some of the more important of these factors are: (1) the depression of respiration brought about by the anæsthetic agent; (2) any resistance to respiration in the anæsthetic apparatus; (3) irritation of the lung tissues by the anæsthetic vapour; (4) hypostasis.

The most common condition is a simple non-infectious bronchitis which results from irritation of the lung tissues. This is characterised by a moist cough with which the temperature is not elevated. It is not serious and will usually clear up within a few days.

Pulmonary œdema will be seen whenever there is any pathology of the left side of the heart, and it may also be caused by hypostasis or by prolonged resistance to respiration in the anæsthetic apparatus. This will occur if an animal is forced to breathe over a long period through an endotracheal tube of which the bore is too small.

Other complications which may occur are pulmonary embolism following phlebitis after an intravenous injection, pulmonary collapse, lung abscesses, and pneumonia.

It has been reported that in human surgery post-anæsthetic pulmonary complications are most common following operations in the upper abdomen when

the diaphragm is immobilised; also following operations for hernia. It would be interesting to receive reports of their incidence in small-animal surgery.

Blood and Urine Samples.

It will frequently be necessary to take samples of blood, urine, and other body fluids for diagnostic purposes, and it may be considered convenient to take such samples whilst an animal is under general anæsthesia. But it is necessary to bear in mind that the anæsthetic itself may bring about changes in the chemistry and physiology of these fluids.

Anæsthesia with chloroform or ether is followed by an increase in capillary permeability and hæmoconcentration. This is not so in the case of barbiturates. Cyclopropane induces an increase in the circulating leucocytes. The oxygen carrying capacity of the blood is reduced by most of the anæsthetic agents.

The secretion of urine is depressed during general anæsthesia with the majority of agents. When ether or chloroform are used, there may be glucosuria and albuminuria. Other changes in the chemistry of the urine are largely dependent upon the changes which take place in the blood.

The chemical and other changes brought about by the various anæsthetic agents in the blood and in the urine have been summarised by Adriani (1942).

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XUM

REVIEWS

BERGEY'S MANUAL OF DETERMINATIVE BACTERIOLOGY, by Robert S. Breed, E. G. D. Murray, and A. Parker Hitchens. Pp. xvi + 1530. Sixth edition. London: Baillière, Tindall & Cox. Price 114s.

MOST of us avoid a study which leads us into the puzzles of the classification and nomenclature of bacteria and viruses. These are taxonomists, and their necessity is shown by the publication of the sixth edition of "Bergey's Manual of Determinative Bacteriology." It has been a reference book for some years, and one of its main purposes is to facilitate the finding of the correct scientific name of a bacterium. An organism cannot be classified until a detailed study of its morphological, cultural, physiological and pathogenic characters have been determined, and the necessity of applying names to bacteria is self-evident. The name used by one person should be understood by another, and there must be some measure of agreement as to the fundamental characteristics of any method of classification used.

Bacteria have two kinds of names, the common or vernacular, and the international or scientific one; both have their uses. The International Association of Microbiologists has agreed that *in so far as they may be applicable and appropriate,* the nomenclatural codes agreed upon by International Congresses of Botany and Zoology should be followed in the naming of micro-organisms. An attempt has been made to use these codes, and bacteriologists will do well if they become conversant with the rules before giving new names to bacteria. Bacteriological taxonomy is a young study, and various opinions have, and still do arise because of the manner of approach made by different microbiologists. The authors of this volume point out that the large number of poorly described species is a reflection on some of the unsatisfactory work in the field of bacteriological taxonomy.

Over 60 contributors, all of whom are specialists, have assisted in the production of this edition, and there are many pleasing features about such a comprehensive book of reference. The sections on the rules of nomenclature and the systems employed for naming and identifying bacteria are valuable; there are two indices, one is of the genera and species and the other of the sources and habitats of the bacteria and viruses. The list of genera and species, with their descriptions, takes up the bulk of the book, and includes synonyms and bibliographies; this latter feature increases the value of the book for purposes of reference. It is, indeed, a book for bacteriologists and not for novices who wish to appear erudite by finding a name for an organism. There is no indication, and there should not be, of the relative importance of species or genera in any particular field of study. For example, to veterinary surgeons, *Clostridium tetani* is infinitely more important than a non-pathogenic organism such as *Clostridium butyricum,* but the latter is treated at greater length with a larger bibliography than the former. Confusion may also arise for those unacquainted with some of the controveries which occur in bacteriological taxonomy.

Some examples will show how the fundamental characteristics of classification are modified according to the knowledge possessed of any particular branch of the subject. Staphylococci and micrococci are merged and the pyogenic golden-pigmented staphylococcus becomes *Micrococcus pyogenes* var. *aureus*. This, in itself, indicates the lack of attention paid to ecology in some groups of organisms; it assumes some importance in the supplement dealing with the viruses. In the Salmonella group, emphasis is laid on serological reactions, whereas in the section on streptococci the antigenic structure is mentioned, but not stressed. It would have been helpful if a table of the Lancefield grouping had been included; it would save having to delve through the text to find the information required. There is thus a curious blend of conservatism and conversion in the volume, due in part to the multiplicity of authors. The conservative schools will not approve of the division of many allied genera; Escherichia, Ærobacter and Klebsiella are segregated because of slight variations in a few biochemical reactions or because of capsulation. It is even doubtful whether the name Escherichia should be used, although T. Escherich may have been the first to isolate Bacterium coli. There is much to be said for the one genus of Bacterium, but this name is given over to a heterogeneous collection of species whose relationships to each other and to other groups are not clear. It is, however, a pleasure to note the disappearance of Eberthella and the return of the causal organisms of human typhoid and of fowl typhoid to the Salmonella group. A new device is the formation of a family of Parvobacteriaceæ or small bacteria which includes Pasteurella, Brucella, Hæmophilus, the Actinobacillus and the glanders bacillus, the latter being known as *Malleomyces mallei*.

There are three supplements, one of which considers the viruses whose affiliations and relationships are still unknown. They are treated as an order with three sub-orders which are separated according to whether the viruses concerned infect bacteria, higher plants, or insects and mammals. Further subdivision occurs according to the type of disease produced. This section may easily be attacked, because of the limited knowledge available of the true biological position of viruses; the reliance placed on the type of host or of the disease produced may lead to difficulties as knowledge increases. A single virus may multiply in a plant host as well as an insect vector, and to accord specific rank to the virus of the swine pox present in Iowa and to include the pox viruses of the ox, the horse, the pig and the sheep among the variants of the small pox virus is confusing to those without specialised knowledge. Some ingenuity is displayed in the names given to some of the viruses; the virus of foot and mouth disease is called *Hostis pecoris,* whilst the viruses of influenza and of canine distemper become *Tarpeia alpha* and *Tarpeia canis* respectively. Hostis and Tarpeia are derived from the Latin, and the former means an enemy or stranger, and the latter is the name of a Roman maiden who treacherously opened a citadel to an enemy. This section may well be the least popular part of the book, because any method employed for the classification of viruses is premature and apt to irritate.

Notwithstanding criticisms, "Bergey" is a volume essential for bac-

teriologists; names and classifications are not so important, for in due course an agreed system will evolve. The value of " Bergey " lies in the wealth of information and the concentration into one volume of an immense bibliography on bacteriological taxonomy. Those who will take the trouble to probe into the book will learn much; it is not suitable for a brief perusal. The classifications adopted and the names given to well-known bacteria and viruses may not be agreeable, but this is the least important part of the book. R.L.

FINDING THE MISSING LINK, by Robert Broom. Pp. 104. London: C. A. Watts & Co. Price 6s.

THIS volume is a record of some of the work of a palæontologist who has devoted much time to the study of fossils, from which he discusses man's evolution. Much of the work recorded deals with actual researches of the author on fossils found in South Africa and elsewhere, as well as the findings of other workers in different parts of the world. He considers in detail the various opinions expressed from time to time and links them up with his own views. The chapter on " Man's evolution " makes very interesting reading.

To those interested in this subject we recommend this work as a well-written, short, well-reasoned account of present-day knowledge.

SHEEP MANAGEMENT AND DISEASES, by H. G. Belschner, D.V.Sc., H.D.A. London: Angus & Robertson. Pp. 718. Price 75s.

TEXTBOOKS on animal husbandry and disease are not plentiful, and we welcome additions to the list. Textbooks dealing with sheep are all too few. This recently published volume, although concerned largely with sheep management and diseases in Australia, will be found to supply information of first-rate importance to both veterinarians and to sheep farmers who desire to probe into the underlying reasons for many of the practices now carried out. Students, both agricultural and veterinary, will find much to interest them in this volume.

The manner in which the author deals with the various subjects shows clearly first-hand knowledge of the practical side of the work and a detailed acquaintance with the literature. The book is well illustrated, although some of the reproductions could well have been clearer in order adequately to illustrate the respective subjects. The sketches, however, are very well done.

The book covers a very wide field, from breeds of sheep, through the different aspects of sheep husbandry, e.g., mutton and wool production, nutrition and wool preparation, to diseases which vary from simple wounds to the specific infections. Chapters are also given on poisoning both by plants and by chemical agents and external and internal parasitic affections are also covered. Useful appendices give tables of information concerning such things as gestation periods, normal temperatures of livestock, common weights and measures, etc., as well as a list of the commonly used terms concerning sheep and wool.

Remembering that this work deals very largely with Australian conditions,

and that many of the descriptions refer to sheep kept under such conditions, there is no doubt that for general information on sheep husbandry and disease the author has fulfilled his purpose as stated in the preface of providing, " in readily available form, information on general sheep management and the diseases of sheep."

We have no hesitation in recommending this volume to all interested in sheep, be they veterinarians or agriculturists. It is written in a style which makes it easy to read, and it is arranged so that reference to any point is quickly obtained.

VETERINARY NOTES FOR HORSE OWNERS, by M. Horace Hayes, F.R.C.V.S. London: Hurst & Blackett, Ltd. Price 50s.

CAPTAIN HAYES, like General Fitzwygram, entered the Veterinary profession late in life. Hayes was 41 when he graduated M.R.C.V.S. in 1883. In In both cases it was their enthusiastic interest in the horse which impelled them to enter the profession. Both men were keen observers, they had a gift with the pen, and they produced a number of manuals which were of great merit, and gained such approbation that they achieved classical standard and an enduring demand which time has in no way diminished.

The sub-title of Captain Hayes's " Veterinary Notes " is " A Manual of Horse Medicine and Surgery," and, indeed, this would be the most appropriate main title, for one cogent criticism that could be made of the book is that it is more suitable for the instruction of the professional man than the amateur horse doctor.

Be that as it may, the demand for this book can be measured in the number of editions (15) that have been published since it was first issued in 1877.

Good as the book has been in the past, the publishers have recognised that it must be kept up to date, for knowledge is never static, and they are to be congratulated on their choice of the man to act as reviser, for Mr. Tutt is a man of wide experience and an acknowledged veterinary authority on the horse. The original arrangement and format remains basically as Captain Hayes wrote it, but the value of the book is enhanced by the many new contributions and comments which have been added by Mr. Tutt in the form of addenda. In this way, that which is good in the old has been retained and new information, which was not available to Captain Hayes, has been added.

In a book of this kind, which is based partly on factual information and partly on conjectual opinions, there must be many items on which the reviewer could cross swords with the author or reviewer. Any such discussion, however, would be on minor points, and again it would only amount to a clash of opinion. Mr. Tutt would be wise to have a look at Fig. 77, for the tyro may be in some confusion as to the site of corn, and at Fig. 54, for a searcher without a hook on the end may become a dangerous weapon in the hands of some people. I am surprised that the onchocercus cervicalis is not mentioned as a potential cause of " Poll Evil," etc. It is surprising, also, to note that the dependant position is to be avoided in a case of " Poll Evil." I have never met with a case of

dislocation of the shoulder in a horse, but the apparent ease with which it can be reduced almost makes me wish that such a case would turn up.

These odd remarks are not made in any spirit of disparagement, for the book is a good book and one which can be read and digested with profit by any young veterinary surgeon or student, for they are abroad in a time when the horse is in a decline and much information which was commonplace twenty or so years ago is now not available to them in their everyday life.

The reviewer has done a good job, and the publishers are to be thanked for again making available this well-known work, and also for the handsome way in which they have reproduced the 284 plates and diagrams. The paper is of good quality the binding good, and the book will grace any horseman's library shelf.

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